

*turning knowledge into practice*

***Life Cycle Assessment Of Organic Diversion Alternatives And Economic  
Analysis For Greenhouse Gas Reduction Options***

# **GHG Tool Overview**

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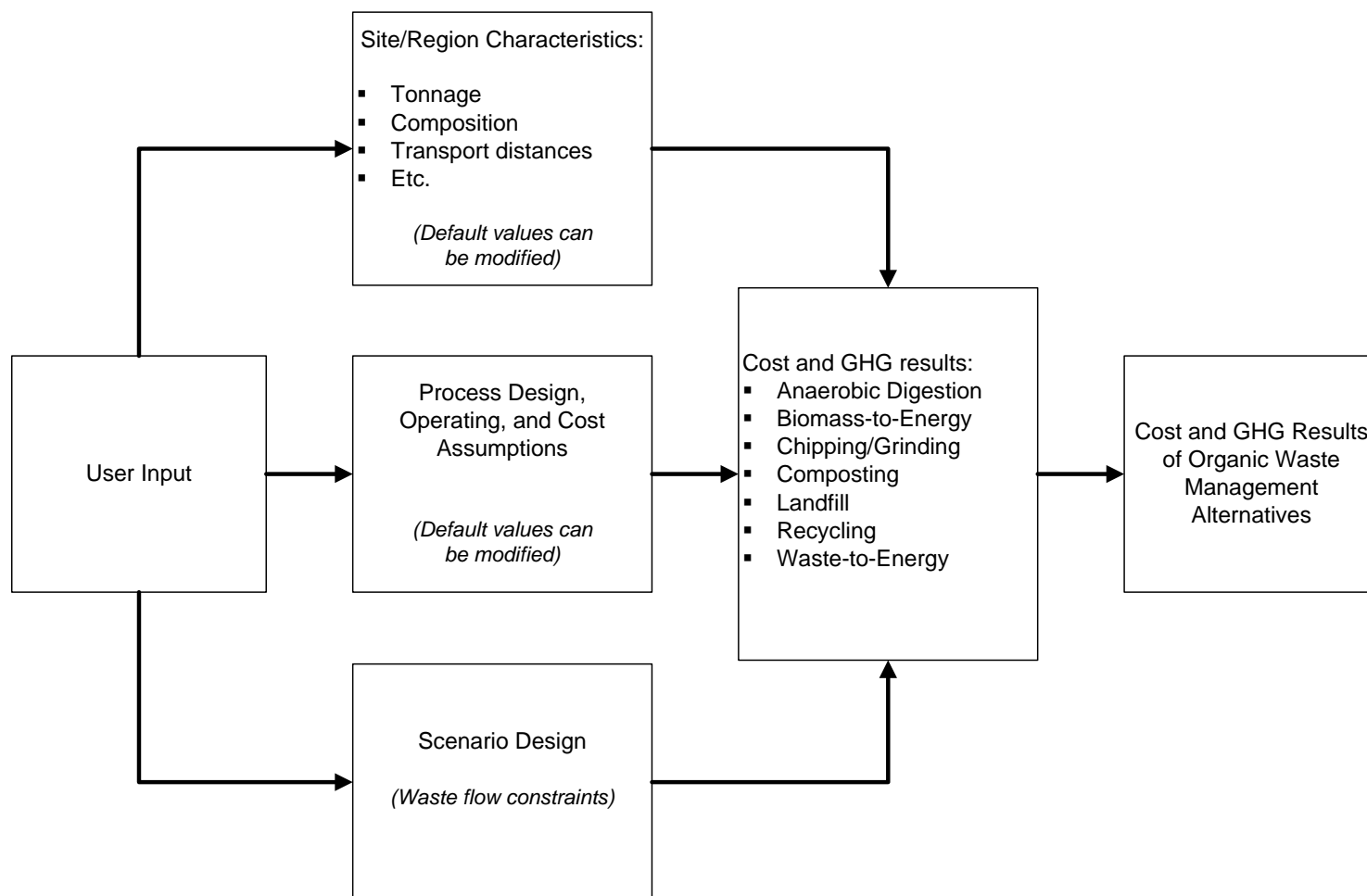
# GHG Tool Goals

- Characterization of costs and GHG emissions associated with organic and recyclable management alternatives.
  - Easy to use
  - Allows for input of region and site-specific data
  - Allows changing key assumptions
- Maintain consistency with the scope, boundaries, and overall framework detailed in the project report:
  - One issue is consistency with climate programs/protocols.
- Coefficients for cost, energy, and GHG emissions are based on the data developed and algorithms selected in the LCA and Economic Analysis portions of the project.

# Differences Between Scenario Analysis and GHG Tool

- Scenario analysis employed fixed data and assumptions whereas GHG tool allows for more flexibility in data and assumptions.
- Scenario analysis was objective based:
  - Minimum cost
  - Minimum GHG emissions
  - Minimum cost while achieving GHG emission reduction targets
  - Minimum energy consumption
- GHG Tool is mass flow (simulation) based:
  - Users define flow of material to alternatives

# Conceptual Framework of the GHG Tool





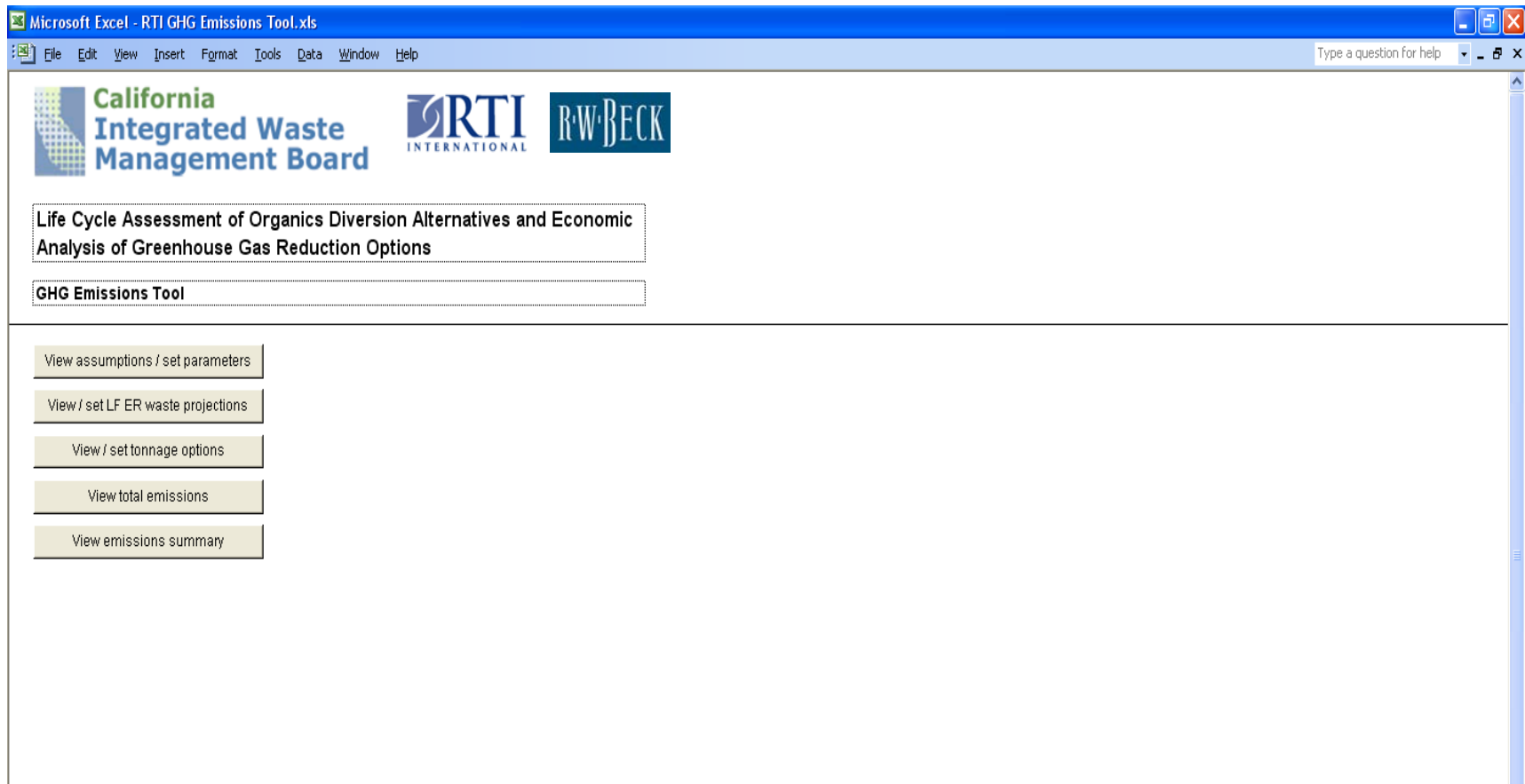
# Key Inputs

- Waste tonnage
  - Select State or regional defaults
  - Input specific tonnage
- Waste composition
  - Can select State or regional defaults
  - Input specific composition
- Mass flow constraints to simulate a scenario
- Key process assumptions
- Key beneficial offset assumptions

# Key Outputs

Output	Output Units
Emissions	Metric tons of GHG/yr Metric tons of carbon equivalents (MTCE)/yr Metric tons of CO <sub>2</sub> equivalents (MTCO <sub>2</sub> E)/yr
Emissions rate	Metric tons of GHG/Metric ton waste MTCE/Metric ton waste MTCO <sub>2</sub> E/Metric ton waste
Costs	Dollars/yr (net present value)
Cost rate	Dollars per ton of waste managed Change in Dollars per ton of waste managed Dollars per MTCE reduced Dollars per MTCO <sub>2</sub> E reduced
Net energy use (generation)	MMBTU
Net energy use (generation) rate	MMBTU/metric ton waste

# *Working* GHG Tool Main Interface



# Waste Tonnage and Composition (User Changeable)

Microsoft Excel - RTI GHG Emissions Tool.xls

File Edit View Insert Format Tools Data Window Help

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1		Landfilled Waste Projections												
2														
3		California Integrated Waste Management Board												
4		Life Cycle Assessment of Organics Diversion Alternatives and Economic Analysis of Greenhouse Gas Reduction Options												
5		GHG Emissions Tool												
6														
7		Return to Main Menu												
8														
193			SCV Tonnage					SCV Percent Tonnage						
194		Landfilled Waste Tonnage	2006	2010	2015	2020	2025	2006	2010	2015	2020	2025		
195		Organics												
196		Leaves and Grass	101,043	115,115	132,325	149,534	166,744	4.8%	4.8%	4.8%	4.8%	4.8%		
197		Prunings and Trimmings	53,870	61,372	70,548	79,723	88,898	2.6%	2.6%	2.6%	2.6%	2.6%		
198		Food	319,596	364,104	418,538	472,973	527,407	15.2%	15.2%	15.2%	15.2%	15.2%		
199		Branches and Stumps	19,627	22,361	25,704	29,047	32,390	0.9%	0.9%	0.9%	0.9%	0.9%		
200		Textiles	37,832	43,100	49,544	55,987	62,431	1.8%	1.8%	1.8%	1.8%	1.8%		
201		Manures	1,395	1,589	1,827	2,065	2,302	0.1%	0.1%	0.1%	0.1%	0.1%		
202		Carpet	56,296	64,136	73,724	83,313	92,901	2.7%	2.7%	2.7%	2.7%	2.7%		
203		Agricultural Crop Residues	0	0	0	0	0	0.0%	0.0%	0.0%	0.0%	0.0%		
204		Remainder/Composite Organics	113,541	129,353	148,692	168,031	187,369	5.4%	5.4%	5.4%	5.4%	5.4%		
205		Green Material ADC	9,957	12,187	14,078	15,970	17,861	0.5%	0.5%	0.5%	0.5%	0.5%		
206		Subtotal Organics	713,158	813,316	934,979	1,056,642	1,178,304	34.0%	34.0%	34.0%	34.0%	34.0%		
207		Paper												
208		Uncoated Corrugated Cardboard	2,830,005	2,829,652	3,132,325	3,683,363	3,737,675	6.9%	6.9%	6.9%	6.9%	6.9%		
209		Paper Bags	706,511	706,158	781,671	919,164	932,702	1.7%	1.7%	1.7%	1.7%	1.7%		
210		Newspaper	1,134,528	1,134,175	1,255,475	1,476,323	1,498,079	2.8%	2.8%	2.8%	2.8%	2.8%		
211		White Ledger	509,822	509,469	563,941	663,129	672,890	1.2%	1.2%	1.2%	1.2%	1.2%		
212		Colored Ledger	195,125	194,773	215,580	253,482	257,200	0.5%	0.5%	0.5%	0.5%	0.5%		
213		Computer Paper	190,558	190,206	210,525	247,536	251,167	0.5%	0.5%	0.5%	0.5%	0.5%		
214		Other Office Paper	441,182	440,829	487,959	573,779	582,222	1.1%	1.1%	1.1%	1.1%	1.1%		
215		Magazines and Catalogs	420,474	420,121	465,036	546,823	554,869	1.0%	1.0%	1.0%	1.0%	1.0%		
216		Phone Books and Directories	3,926,982	3,926,983	5,060,896	6,194,810	7,328,723	0.5%	0.5%	0.5%	0.5%	0.5%		
217		Other Miscellaneous Paper	1,468,892	1,468,539	1,625,607	1,911,572	1,939,749	3.6%	3.6%	3.6%	3.6%	3.6%		
218		Remainder/Composite Paper	2,882,423	2,882,071	3,190,351	3,751,597	3,806,917	7.0%	7.0%	7.0%	7.0%	7.0%		
219		Subtotal Paper	14,706,500	14,702,976	16,989,366	20,221,576	21,562,194	26.8%	26.8%	26.8%	26.8%	26.8%		



# User Input: Common Assumptions

Microsoft Excel - RTI GHG Emissions Tool.xls

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**Assumptions & General Parameters**

California Integrated Waste Management Board  
Life Cycle Assessment of Organics Diversion Alternatives and Economic Analysis of Greenhouse Gas Reduction Options  
GHG Emissions Tool

[Return to Main Menu](#)

Select study year: 2006

Select study region: Statewide

Transportation Distances (One-Way Distance in Miles)					
	Statewide	GLA	SBA	SCV	User Defined
<b>Collection</b>					
Collection route to AD facility	10	10	10	10	10
Collection route to BTE facility	10	10	10	10	10
Collection route to Chipping & Grinding facility	50	50	50	50	50
Collection route to Compost facility	50	50	50	50	50
Collection route to LF	10	10	10	10	10
Collection route to MRF	10	10	10	10	10
Collection route to VVTE facility	10	10	10	10	10
<b>Product</b>					
AD facility to end-use site	94	100	100	100	94
Chipping & Grinding facility to end-use site	10	10	10	10	10
Compost facility to end-use site	10	10	10	10	10
LF facility to VVWTP for leachate treatment	11	11	12	11	11
MRF to domestic carpet markets (Organics)	500	500	500	500	500
MRF to foreign carpet markets (Organics)	6250	6250	6250	6250	6250
MRF to domestic paper markets (Paper)	500	500	500	500	500
MRF to foreign paper markets (Asia) (Paper)	6250	6250	6250	6250	6250
MRF to domestic glass markets (Glass)	500	500	500	500	500
MRF to foreign glass markets (Mexico) (Glass)	1500	1500	1500	1500	1500
MRF to domestic aluminum markets (Metal)	500	500	500	500	500
MRF to foreign aluminum markets (Asia) (Metal)	6250	6250	6250	6250	6250
MRF to domestic ferrous markets (Metal)	1500	1500	1500	1500	1500
MRF to foreign ferrous markets (Asia) (Metal)	6250	6250	6250	6250	6250
MRF to domestic plastics markets (Plastic)	500	500	500	500	500

# User Input: Cost Assumptions

Microsoft Excel - RTI GHG Emissions Tool.xls

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**Assumptions & General Parameters**

California Integrated Waste Management Board  
Life Cycle Assessment of Organics Diversion Alternatives and Economic Analysis of Greenhouse Gas Reduction Options  
GHG Emissions Tool

[Return to Main Menu](#)

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Select study year: 2006

Select study region: Statewide

Collection and Transportation Assumptions	2006	2010	2015	2020	2025
Residential Collection Costs (\$/Ton)					
Statewide	\$150.00	\$164.90	\$185.70	\$209.10	\$235.40
Greater Los Angeles	\$149.40	\$164.20	\$185.00	\$208.30	\$234.50
Southern Bay Area	\$179.10	\$196.90	\$221.70	\$249.70	\$281.10
South Central Valley	\$112.10	\$123.20	\$138.70	\$156.20	\$175.80
Commercial Collection Costs (\$/Ton)					
Statewide	\$120.00	\$131.90	\$148.60	\$167.30	\$188.30
Greater Los Angeles	\$119.50	\$131.40	\$148.00	\$166.60	\$187.50
Southern Bay Area	\$143.30	\$157.50	\$177.40	\$199.80	\$224.80
South Central Valley	\$89.60	\$98.50	\$111.00	\$125.00	\$140.70
Transportation Costs (\$/Mile):					
Statewide	\$1.75	\$1.90	\$2.20	\$2.40	\$2.70
Greater Los Angeles	\$1.70	\$1.90	\$2.20	\$2.40	\$2.70
Southern Bay Area	\$2.10	\$2.30	\$2.60	\$2.90	\$3.20
South Central Valley	\$1.30	\$1.40	\$1.60	\$1.80	\$2.00
Ocean Freight and Warpage Costs (\$/Ton)					
Statewide	\$15.00	\$16.50	\$18.60	\$20.90	\$23.50

# User Input: GHG Assumptions

Microsoft Excel - RTI GHG Emissions Tool.xls

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A	B	C	D	E	F	G
1	Assumptions & General Parameters					
2						
3	California Integrated Waste Management Board					
4	Life Cycle Assessment of Organics Diversion Alternatives and Economic Analysis of Greenhouse Gas Reduction Options					
5	GHG Emissions Tool					
6						
7	Return to Main Menu					
8						

Electricity Grid Mix			
Fuel	Default	User Defined	
Coal	15.70%	15.70%	
Natural Gas	41.50%	41.50%	
Residual Oil	0.00%	0.00%	
Distillate Oil	0.00%	0.00%	
Nuclear	12.90%	12.90%	
Hydro	19.00%	19.00%	
Wood	0.00%	0.00%	
Renewables	10.90%	10.90%	

Key Process Characteristics					
Process	Waste Category	Characteristics	Statewide	GLA	SBA
		Transportation (heavy-duty diesel) carbon emissions factor	1.06E-04	1.06E-04	1.06E-04

# User Input: Mass Flow

Microsoft Excel - RTI GHG Emissions Tool.xls

File

Edit

View

Insert

Format

Tools

Data

Window

Help

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1		Waste Tonnage Options													
2															
3		California Integrated Waste Management Board													
4		Life Cycle Assessment of Organics Diversion Alternatives and Economic Analysis of Greenhouse Gas Reduction Options													
5		GHG Emissions Tool													
6															
7		Return to Main Menu													
8															
9															
10			2006 Total LF ER Waste Tonnage to Waste Management Process - Statewide												
			Base	AD	ASP Compost	BTE	C&D Recycling	Chipping & Grinding	LF Flare	LF ER	LF Vent	Multi-MRF Recycling	Self-Haul/Baling Recycling	Windrow Compost	WTE
11		Organics													
12		Leaves and Grass	1,747,231	0	0	0	0	0	0	0	0	0	0	0	0
13		Prunings and Trimmings	948,145	0	0	0	0	0	0	0	0	0	0	0	0
14		Food	6,031,116	0	0	0	0	0	0	0	0	0	0	0	0
15		Branches and Stumps	123,370	0	0	0	0	0	0	0	0	0	0	0	0
16		Textiles	976,406	0	0	0	0	0	0	0	0	0	0	0	0
17		Manures	37,608	0	0	0	0	0	0	0	0	0	0	0	0
18		Carpet	864,197	0	0	0	0	0	0	0	0	0	0	0	0
19		Agricultural Crop Residues	0	0	0	0	0	0	0	0	0	0	0	0	0
20		Remainder/Composite Organics	1,805,726	0	0	0	0	0	0	0	0	0	0	0	0
21		Green Material ADC	2,656,850	0	0	0	0	0	0	0	0	0	0	0	0
22		Subtotal Organics	15,190,649	0	0	0	0	0	0	0	0	0	0	0	0
23		Paper													
24		Uncoated Corrugated Cardboard	2,482,223	0	0	0	0	0	0	0	0	0	0	0	0
25		Paper Bags	515,003	0	0	0	0	0	0	0	0	0	0	0	0
26		Newspaper	1,026,706	0	0	0	0	0	0	0	0	0	0	0	0
27		White Ledger	577,735	0	0	0	0	0	0	0	0	0	0	0	0
28		Colored Ledger	141,676	0	0	0	0	0	0	0	0	0	0	0	0
29		Computer Paper	141,944	0	0	0	0	0	0	0	0	0	0	0	0
30		Other Office Paper	423,187	0	0	0	0	0	0	0	0	0	0	0	0
31		Magazines and Catalogs	438,447	0	0	0	0	0	0	0	0	0	0	0	0
32		Phone Books and Directories	3,926,982	0	0	0	0	0	0	0	0	0	0	0	0
33		Other Miscellaneous Paper	1,551,116	0	0	0	0	0	0	0	0	0	0	0	0
34		Remainder/Composite Paper	2,443,702	0	0	0	0	0	0	0	0	0	0	0	0
35		Subtotal Paper	13,668,719	0	0	0	0	0	0	0	0	0	0	0	0
36		Glass													

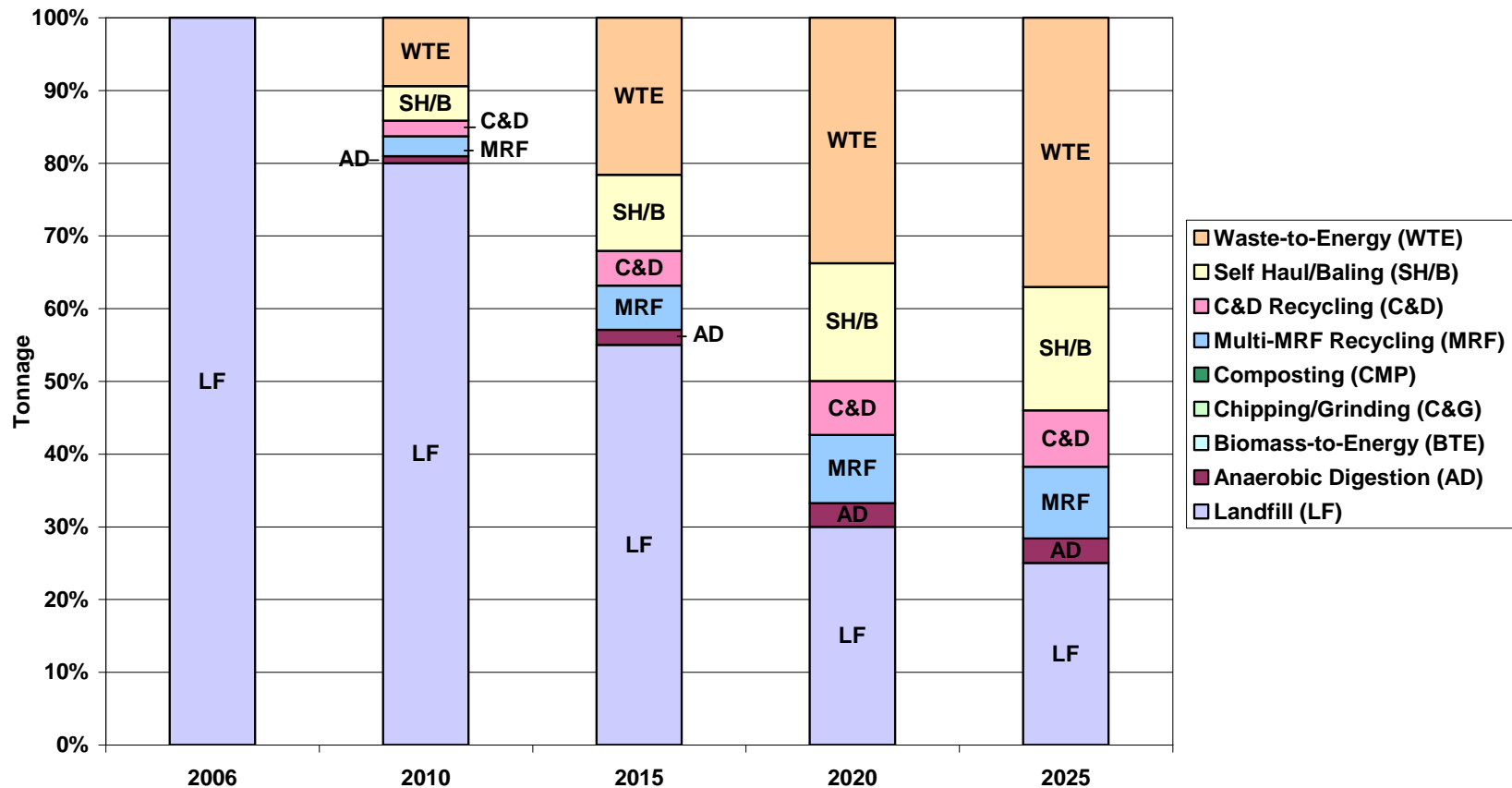


# Results Summary: GHG Example

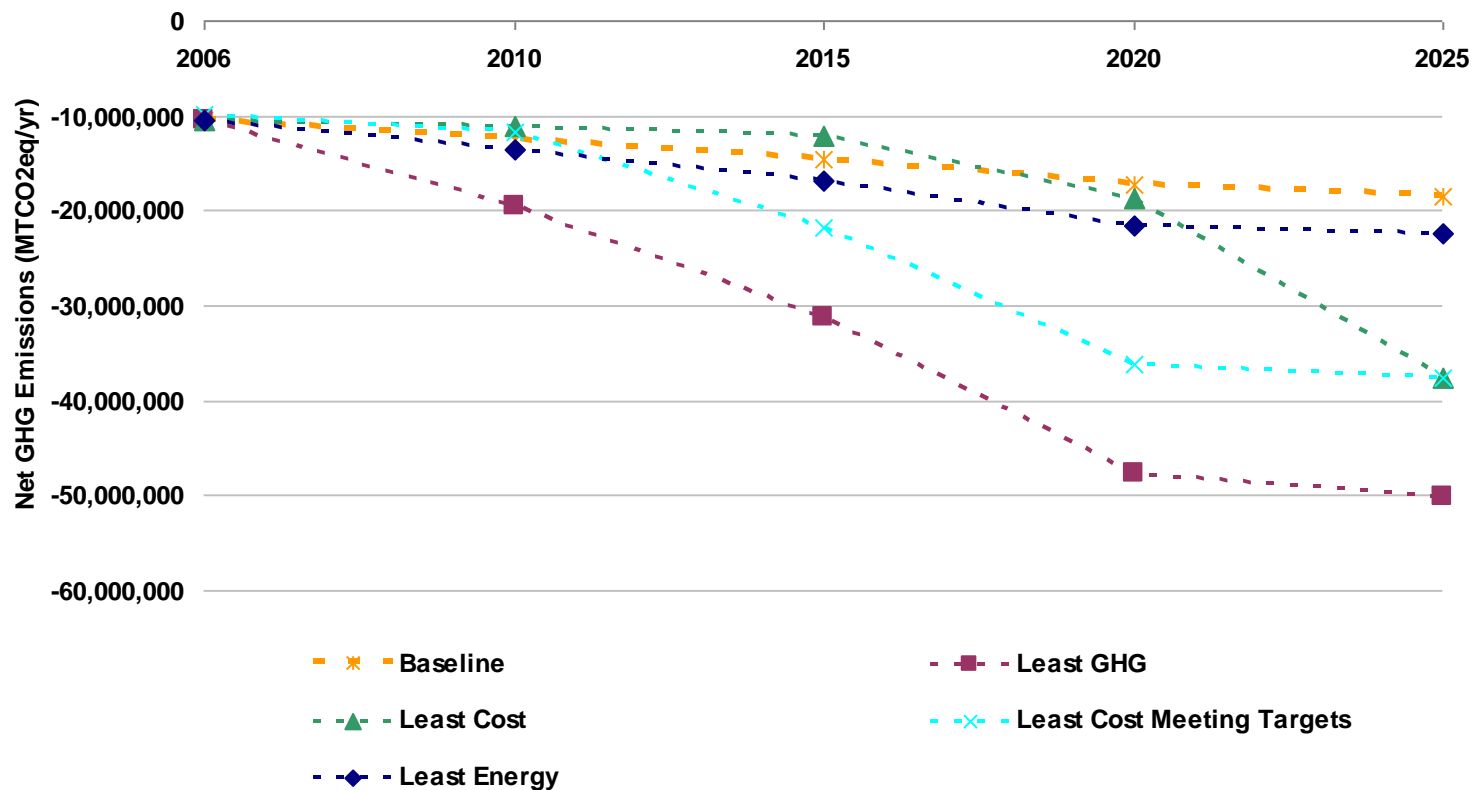
Microsoft Excel - RTI GHG Emissions Tool.xls											
File Edit View Insert Format Tools Data Window Help											
A	B	C	D	E	F	G	H	I	J	K	L
1	<b>Emissions Summary</b>										
2											
3	California Integrated Waste Management Board										
4	Life Cycle Assessment of Organics Diversion Alternatives and Economic Analysis of Greenhouse Gas Reduction Options										
5	GHG Emissions Tool										
6											
7	Return to Main Menu										
8											
32	2010 Net Carbon Emissions (MTCO <sub>2</sub> /yr) from Landfilled Waste Tonnage to Waste Mgmt. Options										
33			Anaerobic	Biomass-	Chipping/		Multi-MRF	C&D	Self Haul/	Waste-	
34	Line	Material Type	Landfill	Digestion	to-Energy	Grinding	Composting	Recycling	Recycling	Baling	Total
35	1	Organics									
36	2	Leaves & Grass	132,216	(38,862)	0	0	0	0	0	0	93,354
37	3	Prunings & Trimmings	189,426	0	0	0	0	0	0	(69,773)	119,653
38	4	Food	(112,595)	0	0	0	0	0	0	(60,167)	(172,762)
39	5	Branches & Stumps	26,127	0	0	0	0	0	0	(9,079)	17,049
40	6	Textiles	4,724	0	0	0	0	0	0	8,703	13,427
41	7	Manures (1)	(125)	0	0	0	0	0	0	(1,292)	(1,417)
42	8	Carpet	(1,590)	0	0	0	0	(1,355,276)	0	0	(1,356,866)
43	9	Remainder	278,977	0	0	0	0	0	0	20,246	299,222
44	10	Green Material ADC	703,465	0	0	0	0	0	0	(259,113)	444,351
45	11	Subtotal Organics	1,220,625	(38,862)	0	0	0	(1,355,276)	0	0	(543,989)
46	12	Paper	507,344	0	0	0	0	0	(3,823,922)	0	(3,316,578)
47	13	Glass	(5,314)	0	0	0	0	(35,203)	0	0	(40,517)
48	14	Metal	(15,305)	0	0	0	0	(1,651,391)	0	0	(1,666,696)
49	15	Plastic	(21,722)	0	0	0	0	(343,787)	0	0	(365,509)
50	16	Construction & Demolition - Lumber	833,535	0	0	0	0	0	(1,690,757)	0	(857,221)
51	17	Total	2,519,164	(38,862)	0	0	0	(3,385,658)	(1,690,757)	(3,823,922)	(6,932,802)

# Charting for Presentation of Results:

## Mass Flow Example



# Charting Function for Presenting Results: Carbon Emissions Example



# Next Steps

- Investigate options for turning carbon factors “on and off” to address consistency with climate programs/protocols.
- Release prototype version of the GHG Tool to stakeholders for review, testing and comment in early August.
- Finalize tool in October 2009 timeframe.